by the Murphy-Martin providence. But there is some small crumb of encouragement for us little fellows; for $25 and $5 a year, we may perchance become a "Fellow" and if such is our luck, just think what we can do: "All Fellows of the College shall be designated a Fellow of the College of Surgeons and shall be authorized and encouraged to use the letters F. C. S. after his name on professional cards, in professional directories and in scientific articles published in surgical literature." It does not say whether the big one of the elect is to be encouraged to use these letters after his name in the articles which may be published in newspapers, thus informing the public of the wonderful discoveries and how he can make the crippled-for-life walk and run about. There is to be still further segregation: "The prospective Fellows are to be divided into four classes, A. B. C and D." The natural interpretation of these cabalistic letters would be the last thing that THE College, or the Regents, or the Governors or any of the muchly bedecorated officials would ever think of; we fear they have no sense of humor. Class "A" one would suppose would indicate Fellows especially handy with the Appendix; class "B" should point out to the incontinent or the suppressed a Fellow who is keen on the Bladder; class "C" might be used to designate those of the Fellows who are highly Commercial and notorious fee-splitters; of course, it is obvious that the man with an ingrowing toe nail will have to pick a Fellow from class "D"—or one who does Divers odd jobs. John Jones can now, if he is lucky enough to be liked by someone who was liked by someone who was liked by the Murphy-Martin "committee," have a brand new lot of stationery printed as follows: "John Jones, M. D., F. C. S., F. of C. S., R. of C. S., G. of C. S., class A (or whatever it may be)." Is there a patient who could get untangled from that string of letters and go to some other less distinguished surgeon? We rather guess not! If that accident should occur, the Regents of THE College will undoubtedly fix up some more titles so as to get some more letters. But think of the state of mind of the poor man with a bellyache who thinks it is appendicitis and sends a messenger boy out to get the card of a real Fellow, goes painfully down the list of letters till he comes to the end and then finds that he has got a "B" Fellow or a "D" Fellow instead of an "A" fellow! Shocking! Oh you Fellow!

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ORIGINAL ARTICLES

INTRATRACHEAL INSUFFLATION ANESTHESIA.*

By SAXTON TEMPLE POPE, M. D., San Francisco.

Experimental physiology often paves the way for the advance of surgery. In the field of thoracic operations, it not only paved the way, it forced surgery to follow. Physiologists had demonstrated the possibility of maintaining artificial respiration and pulmonary ventilation many years ago. Vesalius, in the sixteenth century, first used the laryngeal tube to produce inflation of the lungs. In animal experimentation, Legallois, Monroe, Magendie and Marcy all resorted to an apparatus for artificial respiration, using a tracheal cannula. Surgeons followed rather tardily, employing measures such as the Sauerbruck cabinet, the Tiegel positive pressure apparatus, Green's apparatus and similar devices. The list of experimenters who have attacked the problem is a long one: Matas, Fell, Hans Mayer, P. J. Murphy, Vidal, Karewski, Brauer, Janeway and Robinson, Engelken, Willy Meyer, Elsberg, Boothby, Eisenberg, Peck, Pool, Cotton and many others, all contributing something to the general knowledge of the subject. Sterling Bunnell invented a very ingenious positive pressure mask.

But it remained for Meltzer and Auer of the Rockefeller Institute to originate and popularize the successful method now under consideration. Their work met all the fundamental requirements of the situation. They established the facts that pulmonary ventilation might be maintained by a constant stream of air or oxygen, under definite pressure, being blown in the trachea. This insured the proper oxygenation of the blood, inflation of the lungs, favored the continuance of cardiovascular circulation and permitted, if desired, the induction of narcosis by means of a volatile anesthetic.

All of this is done with a comparatively simple apparatus, easy of operation and absolutely sure in its action. At one move it abolishes the cumbersome, uncertain appliances of the past and opens the thorax to the progress of surgery.

The work of Meltzer and Auer, Elsberg, Flint, Janeway and others has proved that intratracheal anesthesia is not only a successful solution of an important phase of intrathoracic surgery, but is a safe adventure. They even claim that it is safer than the usual surgical narcosis.

Intratracheal intubation eliminates the danger zone—that region lying between the lips and the pulmonary alveoli—where so many of the problems of obstructed respiration have their origin. At the same time it establishes and carries on continuous artificial respiration. The patient cannot die from respiratory failure. This immediately abolishes a large percentage of all anesthesia mortalities.

That most delicate and readily disturbed of all essential functions, respiration, that which quickest shows impending shock, and most elusively departs in the crisis of acapnia, is under the positive control of the anesthetist.

Elsberg has proved that we need fear no damage

* Read before the California Academy of Medicine, January 27, 1913.

from the intratracheal tube. Pneumonia, tracheitis and bronchitis are not more frequent after its employment than after any other anesthesia.

Supported by these facts, and having in view the further progress of surgery in this direction, we have, at the University Hospital, constructed a machine which embodies the essential features of a fully developed intratracheal insufflation apparatus. At this work, Dr. Mary Botsford and I have collaborated under the direction of Dr. Terry.

Utilizing the chassis or framework of a little Tiegel apparat, which had been imported by the late Dr. Bush, but which already had become obsolete through the rapid progress of anesthetics, we laid the foundation for our machine. On this movable base we set an ordinary electric motor and pump, such as is commonly used to fill air tanks for dentists or nasal specialists. From this pump we conduct the air through metal-wound tubing to a large wash bottle, containing and surrounded by warm water. This serves not only as a storage tank for the air, giving a more steady stream, but warms, washes and moistens the atmosphere which must later be forced into the lungs. From this large bottle the air is conducted to a simple arrangement of nickeled tubing and stop cocks, which is so constructed that the air may pass either straight ahead, or go through the ether jar, or do both. As it goes through the ether jar it but skims the surface of the ether. There is no tube leading down under its surface. Carrel, in his laboratory experiments, found that this is all sufficient when the ether and air are warmed. And it absolutely prevents the ether by any chance being sucked up into the tubing and injected into the lungs. This accident has happened at least once in the human in the East, and several times in our experience during the experimental stage of the machine we have seen it occur in animals.

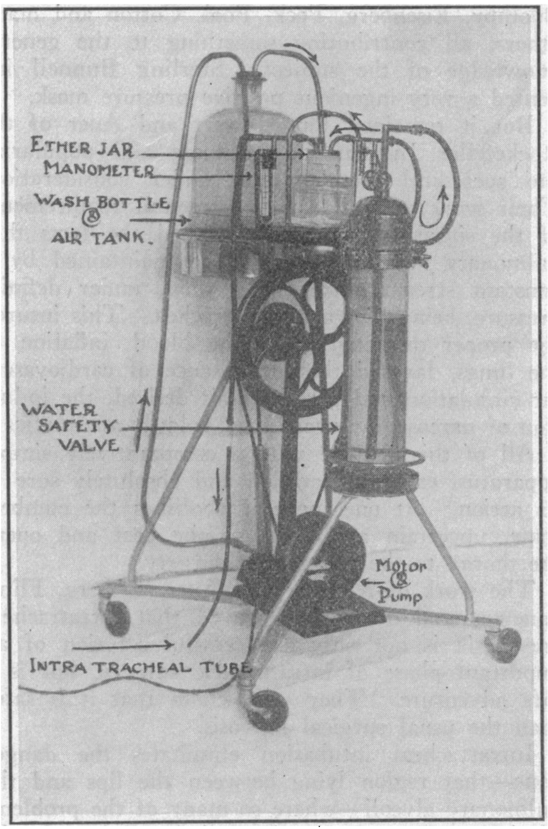

FIG. I.

Before the air comes to the ether jar there is a side track which leads to the safety escape. In this machine this is a water valve. We use it here simply because it was already on the Tiegel apparat. This escape prevents the pressure rising above a certain mark, and permits the regulation of pressure simply by raising or depressing the movable tube which is submerged in the water.

As the filtered, warmed, moistened etherized air is about to enter the final course of tubing on its pulmonary mission, it passes one more restriction—a mercury manometer. Here the pressure is gauged. Physiological experiments have shown that it requires an air pressure of 15 to 20 mm. mercury in the machine fully to inflate the lungs; more than this is dangerous in the opened thorax, and even less is necessary in work on animals. Here a greater pressure, even in the closed thorax, produces rupture of the alveoli and a retro-peritoneal emphysema. This was first demonstrated at the U. C. Research Laboratory by Tait. The ether jar is surrounded by a second jar in which hot water is kept if desirable. Sometimes, when the patient requires a large amount of anesthetic, this added warmth is necessary to increase the volatilization of the ether.

We can with our machine raise the temperature of the etherized air in the delivery tube from 25° C.—the room temperature—to 48° C.—a temperature too great for safety. Experience has taught us that water at 60° C. in the jars gives the required 36° in the catheter.

There is nothing original in our machine. We have simply taken the things at hand and applied them to the requirements of the case. The essential is a constant flow of warm, moist air, carrying varying proportions of ether, under a pressure adjustable from 10 to 20 mm. mercury, and incapable of rising above this.

We have also constructed another machine—much less cumbersome, having the pump separate, a rubber bag to equalize the pressure of air, smaller wash bottles, mercury safety valve, electric lights to produce warmth, and a monovalve regulator for the air and ether.

Both machines also have a stop cock for the attachment of an oxygen tube, so that this may be run through the ether or serve if the pump should break, and to be used at the last of the anesthesia to blow out the ether, thus quickly rousing the patient from his narcosis.

Having your machine and your patient, the next thing is to connect them. This is done in the adult by the introduction of a No. 21 or 22 F catheter into the trachea, a distance of 25 or 30 centimeters from the teeth. This is no easy matter—in our experience. It is advisable to have administered a preliminary injection of morphine and scopalamine, and then to have the patient thoroughly anesthetized with ether.

In this condition, after inserting a mouth gag, the first or second finger is put well down the throat, the epiglottis located and pushed well forward; then the introducer, loaded with the disconnected catheter, is passed along the finger into the rima glottidis. As soon as the catheter is in the larynx, you are made aware of the fact by the hissing of air in the tube and the coughing expiration of the patient. A silent, quiet insertion is characteristic of a miss: an esophageal catheterization. When the tube really is in the larynx, it is pushed down well and the introducer slipped off; then the connection is made with the machine. It is well to have the machine running all the time, so that no interruptions occur in the anesthesia and respiration. Sufficient air escapes around the catheter in the trachea for all purposes of pulmonary ventilation.

We have tried the introduction of this tube with the assistance of the laryngoscope, but have found it more difficult with the patient on the operating table than we anticipated.

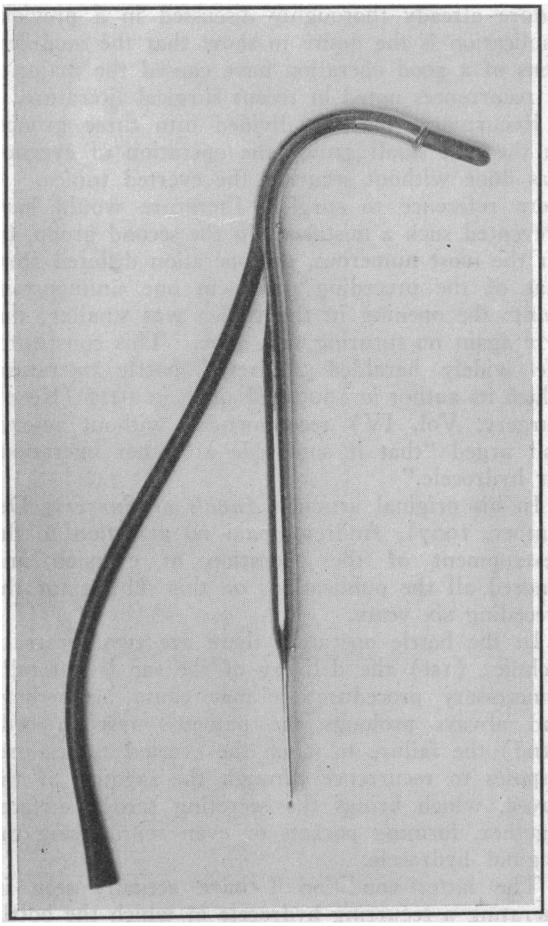

FIG. II.

In some subjects, where the jaws are projecting and there is more or less ankylosis, the introduction by touch is very difficult; but as we gain experience, it becomes progressively a more simple process. The introducer is simply a large hollow sound, permitting the passage of a 23 F catheter. Boothley I believe invented it.

Our catheters are not boiled, because this softens them, but they are cleaned in a phenol solution and lubricated with vaseline.

Some of our early patients complained of sore throat after recovery from the anesthesia, and a little laryngitis; but this we believe was due more to the unsuccessful attempts at intubation than to the irritation of the tube when in place.

Anesthesia proceeds smoothly from this point on. The patient can quickly be brought under control of the anesthetic. Respiration continues along with the insufflation in the lighter degrees of narcosis. In more profound sleep, respiratory excursions are abolished, without particular danger to the patient. They return naturally upon lessening the narcosis or after stopping the air current. This extreme phase, however, is seldom necessary and need not be approached unless desired. At any time the ether may be cut out entirely and only air or oxygen administered.

At the termination of the operation the patient can be roused within two or three minutes by blowing him out with oxygen.

The tracheal tube is left in until breathing is good, and a slight coughing warns us of the return of the laryngeal reflex.

We have used this apparatus in eighteen cases at the University Hospital. Only two of this number have been thorax cases. But we have found it of unquestionable service in operations upon the tongue and jaw. Heretofore, even under the smoothest anesthesia, these operations have been punctuated by coughing, choking, obstructed respiration, reflex laryngeal spasm, inspiration of blood and interruptions without number. With intratracheal anesthesia they become a quite easy performance. The blood takes care of itself. There is no danger of inspiration of clots or respiratory failure.

Meltzer and Auer have computed that the proper size catheter for insufflation is one that fills one-half the aperture of the larynx. If increased obstruction be necessary to inflate the lungs fully at the closure of a thoracic operation, compression of the throat above the thyroid cartilage will serve the purpose.

We have not tried the Killian laryngoscope to assist the intubation. Possibly this would be a marked advantage.

The Sewell mouth gag, when tried, was no help in adults. With children the epiglottis can be seen plainly with this instrument in place, which facilitates the intubation very materially.

In the experimental laboratory we use it constantly as a method of anesthesia, and there it certainly reduces the anesthesia risk. It is practically impossible to kill an animal under intratracheal anesthesia, unless it be bled to death. Cardiac death is exceptional in laboratory animals. Respiratory failure was an ever present menace.

Carrel has used the same form of anesthesia for several years, and it has made possible some of his most astonishing experiments. A number of these we have duplicated in our laboratory, and we expect a definite advancement in surgical research from the employment of this very useful, safe, and indispensable method of anesthesia.